

### REMARKS

Claims 1-2 and 4-15 are currently pending in the application. Claim 3 has been canceled and claims 7-9 and 15 have been withdrawn from consideration without prejudice. Please note that the Examiner incorrectly indicated in the Office Action that claims 1-14 are pending in the application and that claims 7-9 are withdrawn from consideration. It is believed that the Examiner overlooked claim 15 which Applicants understand to be withdrawn from consideration since it directly depends from method claim 7. Applicants request that the proper disposition of the claims be reflected in the next written Office communication.

**At the outset, it is also noted that the Examiner has not returned the PTO/SB/08A Form submitted with the Supplemental Information Disclosure Statement, filed on January 14, 2003. It is respectfully requested that the Examiner initial and return to the undersigned the PTO/SB/08A Form, indicating that the reference cited therein has been considered.**

The Examiner has rejected claims 1-3, 6 and 10-14 under 35 U.S.C. §103(a) as being unpatentable (obvious) over U.S. Patent No. 5,030,440 of Lywood, *et al.* ("Lywood") in view of either U.S. Patent No. 6,110,862 of Chen, *et al.* ("Chen") or U.S. Patent No. 6,103,660 of Yperen, *et al.* ("Yperen"). The Examiner contends that Lywood discloses a process for subjecting a gas stream containing hydrogen, carbon monoxide (CO) and steam to the water gas shift reaction, and teaches that the catalyst may constitute platinum (Pt), palladium (Pd), or mixtures thereof on an alumina support. The Examiner acknowledges that Lywood does not disclose that the alumina support should have a specific surface area of at least 10 m<sup>2</sup>/g or more. However, the Examiner asserts that Chen teaches that it is well known in the art to provide oxidation catalysts in the form of a catalytic material comprising a refractory inorganic oxide

support material, such as activated alumina, on which is dispersed a catalytic metal component such as a platinum group metal component. The Examiner also asserts that Chen discloses that the alumina should be characterized by a high surface area of at least about 60 m<sup>2</sup>/g.

Further, the Examiner cites Yperen contending that Yperen discloses that catalysts should typically comprise a catalytically active component applied in highly dispersed form on support materials in order to assure a high catalytic activity with the smallest possible amounts of active components and that, to this end, support materials are used which have a large specific surface area to receive the catalytically active components. The Examiner argues that Yperen specifically teaches that the support should be aluminum oxide with a BET surface area of at least 100 m<sup>2</sup>/g.

The Examiner concludes that it would be *prima facie* obvious from either Chen or Yperen to provide the alumina support disclosed at column 3, lines 56-60 of Lywood with a BET specific surface area of at least 10 m<sup>2</sup>/g, since Chen and Yperen both disclose that it is desirable in the art of catalysis that the support material be aluminum oxide having a high specific surface area of at least 10 m<sup>2</sup>/g.

Additionally, the Examiner rejects claims 1-3 and 10-14 under § 103(a) as being unpatentable (obvious) over U.S. Patent No. 3,872,025 of Singleton ("Singleton") in view of either Chen or Yperen. The Examiner contends that Singleton discloses a water gas shift reaction and teaches that the catalyst may be alumina-supported Pt. The Examiner acknowledges that Singleton does not specifically disclose that the alumina support should have a specific surface area of at least 10 m<sup>2</sup>/g but relies on Chen and Yperen in this regard. The Examiner concludes that it would be *prima facie* obvious from either Chen or Yperen to provide the alumina support for the catalyst disclosed at column 6, lines 19-31 of Singleton with a BET

specific surface area of at least 10 m<sup>2</sup>/g, since Chen and Yperen both disclose the benefits of employing such high surface area supports in the field of catalysis.

Moreover, the Examiner rejects claims 4-5 under 103(a) as being unpatentable over Lywood or Singleton in view of either Chen or Yperen as applied to claim 1 above and further in view of U.S. Patent No. 5,830,425 of Schneider, *et al.* ("Schneider"). The Examiner contends that it would be obvious from Schneider to stabilize the catalyst of either Singleton or Lywood with either cerium (Ce) or zirconium (Zr), since Schneider teaches, in Example 8 at column 8, line 23 to column 9, line 24, that water gas shift catalysts may be stabilized with either Zr oxide or Ce oxide. The Examiner argues that it would be expected from Schneider that the catalyst of either Singleton or Lywood could also be stabilized with Zr or Ce, since the catalyst of Schneider may contain a Pt group metal.

With regard to claim 6, the Examiner argues that it would be within the skill of one of ordinary skill in the art to determine a suitable or optimum amount of Pd to employ in combination with the Pt in the catalyst disclosed at column 3, lines 56-60 of Lywood. With regard to claims 12-14, the Examiner contends that Chen, and similarly Yperen, disclose that the refractory carrier substrate may be cordierite or mullite in the form of a honeycomb. Finally, with regard to claim 10, the Examiner asserts that catalyst carriers are conventionally in the form of pellets and that it would be obvious to employ the aluminum oxide support of Lywood in the form of pellets, especially since Chen and Yperen suggest that the support may be any "catalytically inert carrier body."

Applicants traverse the Examiner's §103 rejections and the arguments in support thereof for the reasons that follow.

Applicants have canceled claim 3 and amended claim 1 such that claim 1 now

recites, in part, that the shifting catalyst body comprises a carrier composed of at least one metal oxide selected from the group consisting of Ce, Zr and Ti, having a BET specific surface area of at least  $10 \text{ m}^2/\text{g}$  and Pt supported thereon (see amended claim 1). None of the cited prior art references (Lywood, Chen, Yperen, Singleton and Schneider) teaches or suggests a shifting catalyst body comprising a carrier composed of Ti oxide and platinum (Pt) supported thereon as recited in amended claim 1. Further, with the exception of Schneider, the cited references do not describe a catalyst body that comprises Ce oxide or Zr oxide.

Schneider describes catalysts as being chromium-free catalysts which contain, in part, at least one oxide of a precious metal from the platinum group (see col. 3, lines 7-19). Schneider also teaches that "instead of [using] the stabilizing components Zr or Ce, a precious metal is used . . .", thereby teaching that a precious metal oxide is used as a component of the catalyst in place of, and not with, Zr or Ce oxide stabilizing components (Schneider, col. 9, lines 18-19). This is clearly seen in Example 8 of Schneider where 0.42 grams of palladium (Pd II)-acetate is used instead of, for example, zirconyl sulfate (33%  $\text{ZrO}_2$ ) or  $\text{Ce}(\text{SO}_4)$  (compare Schneider, Example 8 to Examples 1 and 2). Thus, Schneider teaches away from the use of either Ce oxide or Zr oxide with a precious metal and therefore, like the other cited references, does not teach or suggest a shifting catalyst body comprising a carrier composed of Ce or Zr oxide and Pt supported thereon as specified in amended claim 1.

Further, the cited prior art references do not provide any motivation to modify and combine the references as suggested by the Examiner, nor is there a reasonable expectation of success from such modification and/or combination. As stated above, the Examiner contends that it would be [would have been] obvious from Schneider to stabilize the catalyst of either Singleton or Lywood with either Ce or Zr, since Schneider teaches, in Example 8 at column 8,

line 23 to column 9, line 24, that water gas shift catalysts may be stabilized with either Zr oxide or Ce oxide. The Examiner argues that it would be expected from Schneider that the catalyst of either Singleton or Lywood could also be stabilized with Zr or Ce, since the catalyst of Schneider may contain a Pt group metal. Applicants most respectfully, but strenuously, disagree for the reasons already stated above as well as those that follow.

Lywood discloses a hydrogen production process wherein a gas stream containing hydrogen, CO and steam is passed over an iron-free catalyst to catalyze the shift reaction, thereby increasing the recoverable heat and hydrogen and decreasing the CO to carbon dioxide of the gas (Abstract). Catalysts that can be used in the process of Lywood include metals such as Pt or, preferably, Pd or mixtures thereof on a support of refractory material such as alumina or a calcium aluminate cement (col. 3, lines 56-60). Other types of catalysts can also be used effectively in processes disclosed in Lywood (see, e.g., col. 4, lines 14-60). However, since Schneider teaches away from the use of either Ce oxide or Zr oxide with precious metals, such as Pt and Pd, there is no motivation to combine Lywood and Schneider as suggested by the Examiner.

Singleton teaches a method of making high pressure synthetic gas containing hydrogen from a low grade, industrial gas containing CO after the initial removal of carbon dioxide (Abstract and claim 1). The method taught in Singleton can use a relatively wide range of known catalysts for the reactions in the disclosed shift convertor and the methanol reactor (col. 6, lines 22-24). Catalysts include alumina-supported cobalt (Co), magnesia or Pt, and metal oxide-promoted copper-based materials (col. 6, lines 24-28). However, similar to the argument with regard to Lywood, since Schneider teaches away from the use of either Ce oxide or Zr oxide with precious metals, such as Pt, there is no motivation to combine Singleton and Schneider as

suggested by the Examiner.

Moreover, the cited prior art references do not provide a reasonable expectation of success from modifying and/or combining the prior art references as suggested by the Examiner. The reasonable expectation of success, like the suggestion to modify and/or combine cited prior art references, must come from the references without reference to Applicants' specification. The claimed invention provides a hydrogen refinement apparatus comprising, in part, a CO shifting catalyst body that comprises a carrier composed of at least one metal oxide selected from the group consisting of Ce, Zr and Ti, having a BET specific surface area of at least  $10 \text{ m}^2/\text{g}$  and Pt supported thereon, such that CO in said reformed gas is capable of being reduced by a shift reaction in said reaction chamber (see claim 1). The catalyst body of the apparatus provides high catalytic activity since the selected metal oxides are relatively stable in the presence of alkalis and are unchanged in the presence of an acidic or basic Pt salt (see, e.g., page 15, lines 8-10). In contrast, metal oxides altered by the presence of a Pt salt result in a reduction of the activity of catalyst bodies (page 15, line 10-13).

Further, in the case where the metal oxide is Ce oxide, oxygen in the Ce oxide is easily transferred in the lattice such that Ce oxide is easily oxidized and reduced (page 15, lines 16-19). Thus, when Pt is on the Ce metal oxide, as recited in the claimed invention, adsorption of CO is facilitated as is the production of carbon dioxide (page 15, lines 19-24). Also, the use of Ce suppresses or inhibits a methanization reaction on the Pt catalyst and improves catalyst activity at lower temperatures (page 16, lines 13-16).

For the reasons stated above, the cited prior art references: do not teach or suggest all of the elements of amended claim 1; do not provide a motivation to modify and combine the references; and do not provide a basis for a reasonable expectation of success. Therefore, the

presently claimed invention, as recited in amended claim 1, would not have been *prima facie* obvious in view of the cited prior art references. Further, since pending claims 2, 4-6 and 10-14 depend from claim 1, either directly or indirectly, these claims would also not have been *prima facie* obvious in view of the cited prior art references.

Moreover, even if *prima facie* obviousness could be shown based on any of the above-noted references or combination of references, such *prima facie* obviousness is sufficiently overcome by Applicants' improved and unexpected results. More specifically, the hydrogen refinement apparatus of the present invention provides a relatively simple means for actively treating CO in an improved heat resistant shifting catalyst body, while reducing the negative effects associated with oxygen introduction during repetitive start-up and shut-down of system operations thus providing an apparatus that operates stably over a long period of time (see page 4, lines 15-22; see also Examples 1-7 and Comparative Examples 1-2, page 22, line 10 to page 34, line 11).

In view of the forgoing amendments and remarks, Applicants submit that the pending claims are patentably distinct from the prior art. Accordingly, reconsideration and withdrawal of the rejections, and an early Notice of Allowance are respectfully requested.

Respectfully submitted,

**KIYOSHI TAGUCHI ET AL.**

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(Date)

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